

Efficient Distribution System using HVDS Concepts

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Abstract:- Requirement of The Power in urban and metro areas is very high with an exponential growth. The distribution system with LVDS results in multiple loads fed from a bulk power transformer resulting in higher regulation at the tail ends. Moreover there is an increase in losses of the system, power factor, voltage profile and performance are affected in the existing distribution system. In this work, a high voltage distribution system has been proposed and the simulation studies were carried out for an existing TNEB High Court Sub Station using PSCAD Software. The simulation studies reveals that the system voltage at the tail end increases approximately by 10Volts. This may result in Extended lifetime of the equipment and reduction in system loss. New transformers of low capacity may have to be introduced for implementing the proposed system and the existing transformer of high capacity have to be relocated suitably to achieve the advantage of HVDS. The investment may be two times compared to LVDS and the increased cost is affordable as HVDS is more beneficial.

Keywords:- Distribution systems, Proposed, Tail end Voltage Analysis.

I. INTRODUCTION

The distribution system is the most visible part of the supply chain, and as such the most exposed to the critical Observation of its users. The largest investment, maintenance and operation expense, and the Object of interest to government, financial agencies, and associations of concerned citizens are the main advantages about 30 to 40 % of total investments in the electrical sector go to distribution systems, but nevertheless, they have not received the technological impact in the same manner as the generation and transmission systems. Many of the distribution networks work with Minimum monitoring systems, mainly with local and manual control of capacitors, sectionalizing switches and voltage regulators; and without adequate computation support for the system's operators. Nevertheless, there is an increasing trend to automate distribution systems to improve their reliability, efficiency and service quality. Ideally, losses in an electric system should be around 3 to 6%. In developed countries, it is not greater than 10%. However, in developing countries, the percentage of active power losses is around 20%. Therefore, utilities in the electric sector are currently interested in reducing it in order to be more competitive, since the electricity prices in deregulated markets are related to the System losses.

In India, collective of all states, in 2008 the technical and non technical losses are accounted as 23% of the total input energy. To manage a loss reduction program in a distribution system it is necessary to use effective and efficient computational tools that allow quantifying the loss in each different network element for system losses reduction. Various authors have discussed loss minimization in different aspects. In order to increase the efficiency of the distribution electrical networks, a reconfiguration process was applied to improve the reliability indices.

II. FACTORS CONTRIBUTING FOR HIGH TECHNICAL LOSSES

The main factors that contribute for high technical losses are usage of lower size conductors, low voltage pockets, lack of reactive power control, etc. The methods to reduce technical losses in the order of priority based on cost impact are

1. Re configuration (change over of loads or feeding source).
2. Re conduct ring (Replacing existing conductor by higher size or conversion of single to double circuit).
3. Shunt or series capacitor installation (switched and fixed).
 4. Auto voltage booster.
 5. Additional link lines.
6. Combination of two or more of the above.
7. As a last resort to go in for another sub-station followed up by reconfiguration.
8. Software tools are available for the studies to be made is termed as IOSP (Integrated Optimum System Planning) in order to determine and prioritise such works, which result in maximum

LRVI (loss reduction and voltage improvement)

with least investment. Based on cost benefit ratio, the best option for investment can be chosen.

9. Combination of GIS and network analysis tools like Power Net.

HVDS: The distribution systems shall be at high voltage and the L.T. system shall be the least or eliminated as far as possible. HVDS or high voltage distribution systems by converting existing LVDS is in progress in many Discoms reducing the technical losses appreciably. This can be explained by one single illustration that for a 100

KVA load the amperage at 11KV is 5 Amps where as it is

140 Amperes at L.T. voltage of 415 Volts.

III. LOSSES-REASONS AND REMEDIES

The major amount of losses in a power system is in primary and secondary distribution lines; while transmission and sub-transmission lines account for only about 30% of the total losses. Therefore the primary and secondary distribution systems must be properly planned to ensure within acceptable limits. The factors contributing to the increase in the lines losses in the primary and secondary systems:

1. Lengthy Distribution lines

In practice, 11 KV and 415 volts lines, in rural areas are hurriedly extended over long distances to feed loads scattered over large areas. Thus the primary and secondary distribution lines in rural areas; by and large radially laid, usually extend over long distances. This results in high line resistance and therefore high 2R losses in the line.

2. Inadequate Size of Conductors

As stated above, rural loads are usually scattered and generally fed by radial feeders. The conductor size of these feeders should be adequate. The size of the conductors should be selected on the basis of KVA X KM capacity of standard conductor for a required voltage regulation.

3. Distribution Transformers not located at Load center on the Secondary Distribution System

Often DTs are not located centrally with respect to consumers. Consequently, the far off consumers obtain an extremely low voltage even though a reasonably good voltage levels were maintained at the transformer secondaries. This again leads to a higher line losses. (The reason for the line losses increasing as a result of decreased voltage at the consumers terminally are explained in III-5)

Therefore in order to reduce the voltage drop in the line to the farthest consumers, the distribution transformer should be located at the load center to keep voltage drop within permissible limits.

4. Over-rated Distribution Transformers and hence their Under-Utilization

Studies on 11 KV feeders have revealed that often the rating of DTs is much higher than the maximum KVA demand on the feeder. Over rated transformers draw an unnecessary high iron losses. In addition to this iron losses in over rated transformers the capital costs is also high. From the above it is clear that the rating of DT should be judiciously selected to keep the losses within permissible limits.

For an existing distribution system the appropriate capacity of distribution transformer may be taken as very nearly equal to the maximum KVA demand at good pf (say 0.85) Such an exercise has been carried out for a number of distribution systems and transformers with capacity of 25, 63, 100, 160, 315 KVA and standardized with different power factors and diversity factors.

5. Low Voltage (less than declared voltage) Appearing at Transformers and Consumers Terminals:

Whenever the voltage applied to induction motor varied from rated voltage, its performance is affected. Within permissible voltage of +/- 6% of the affect practice, the supply voltage varies by more than 10% in many distribution systems. A reduced voltage in case of induction motor results in higher currents drawn for the same output. For a voltage drop of 10%, the full load current drawn by the induction motors increase by about 10% to 15% the starting torque decreases by nearly 19% and the line losses in the distributor increases by about 20%.

As the bulk load of rural areas and small scale industrial areas consists of induction motors, the line losses in the concerned distribution systems may even touch 20%.

The above situation is corrected by operating an "on-load- tap changing" in the power transformers situated at high voltage sub-stations 66/11 KV sub-stations and providing on the 11 KV feeders a combination of switched capacitors and automatic voltage regulators.

Further, the "off load tap changing" in distribution transformers is adjusted prior to the

commencement of agricultural load season, which is readjusted before the one-set of monsoons when the rural load is small the off- load tap changing gear is available.

6. Lower Power Factor:

In most LT distribution circuits, it is found that the PF ranges from 0.65 to 0.75. A low PF contributes towards high distribution losses.

7. Bad Workmanship Resulting in Poor Contacts at

Joints and Connections

Bad Workmanship contributes significantly towards increasing distribution losses.

IV. PROPOSED TNEB UNBALANCED SYSTEM

The proposed method is based on the assumption that the distribution network is unbalanced and as such the single- line representation is not adequate. For a more accurate modeling it is necessary to represent with more detail the three-phase, two-phase and one-phase elements that make up the system. This is done using a basic construction block to represent the electrical impedance and/or admittance of each element.

A. Overhead Transmission Lines Transmission lines are represented by calculating their Three-phase impedance matrix and the three -phase capacitance susceptance matrix. A primitive impedance matrix is calculated using the modified Carson's equations [2] [3]. The size of this primitive impedance depends on the number of conductors in the transmission line and must be reduced to the standard matrix block size of 3x3. A similar procedure is followed to calculate the capacitive susceptance matrix using the primitive potential coefficient matrix. The basic information required from the user is the type of conductors and the distances for the configuration.

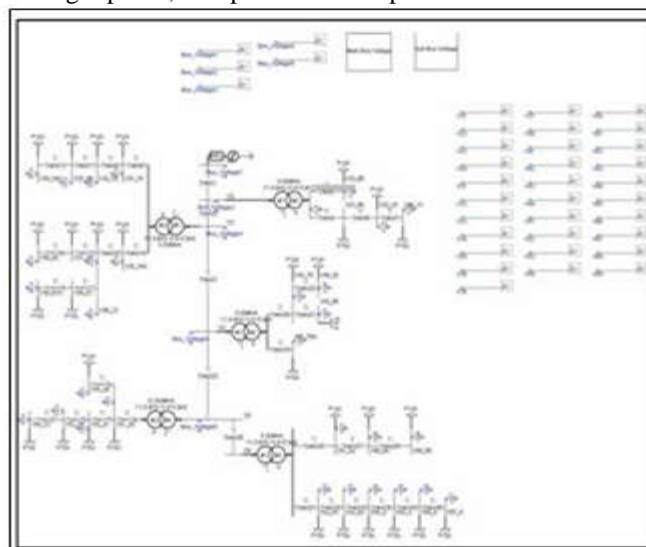
B. Cables

Similarly to overhead transmission lines, the underground cables were modelled using modified Carson's equations and especially derived expressions for their shunt admittances. For the case of cables several special calculations are required to relate the cables' quantities to the general form of these modified equations. These calculations strongly depend on the type of cable and the programme supports concentric neutral, concentric neutral with additional neutral and tape shielded.

C. Transformers Using the two port representation typical transformers were modelled by calculating their three-phase impedance matrix as shown in [2]. This matrix representation takes into account the actual winding impedance of the transformer and its connection type. Models were developed for the following connections (using typical 300 shifts) delta- grounded wye, ungrounded wye-delta, grounded wye- grounded wye and delta-delta. Additionally, the models allow for the simulation of single-phase units that are common in applications such as lighting.

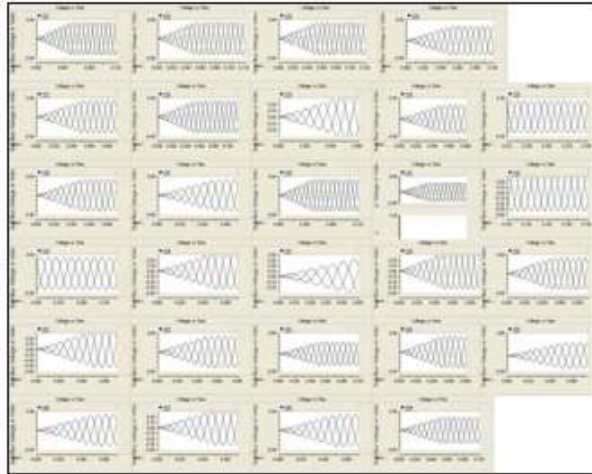
D. Loads

Loads were represented as impedance constant elements connected in wye or delta. The load model allows for representation of single-phase, two-phase or three-phase loads.



Existing TNEB Unbalanced System Layout in PSCAD

Graph Result for Unbalanced System

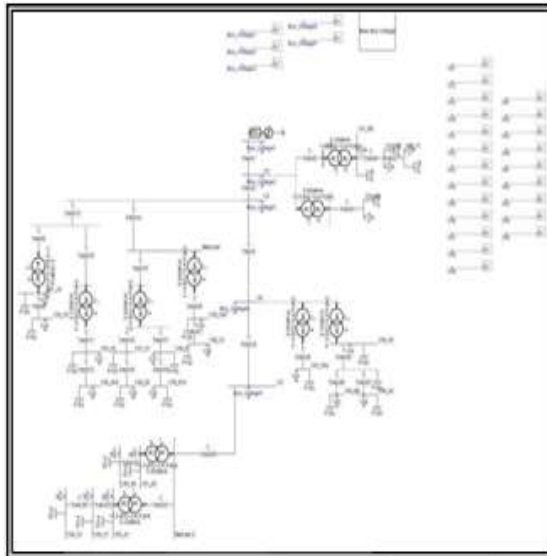


Proposed TNEB Unbalanced System in PSCAD



Graph Result for Proposed System

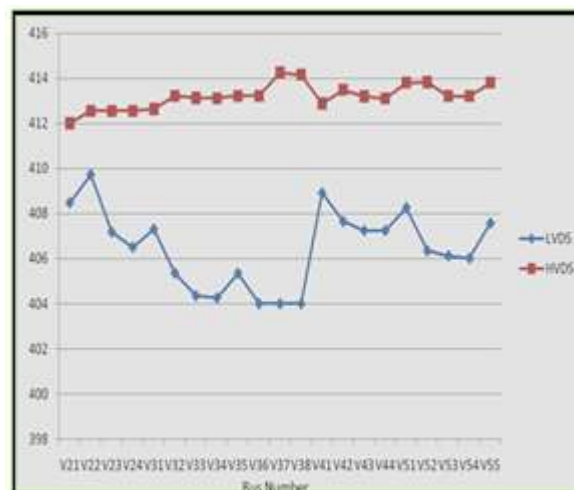
Existing vs. Restructured System



Comparison Graph

Voltage Source	LVDS O/P	HVDS O/P
V21	408.47V	411.99V
V22	409.72V	412.54V
V23	407.17V	412.54V
V24	406.50V	412.54V
V31	407.3V	412.64V
V32	405.35V	413.216V
V33	404.35V	413.116V
V34	404.26V	413.110V
V35	405.35V	413.216V
V36	404.00V	413.216V
V37	404.00V	413.21V
V38	404.00V	413.816V
V41	408.90V	412.87V
V42	407.64V	413.49V
V43	407.24V	413.20V
V44	407.24V	413.10V
V51	408.26V	413.816V
V52	406.34V	413.83V
V53	406.12V	413.21V
V54	406.01V	414.26V
V55	407.57V	414.16V

Existing vs. Restructured System



Payback Period by Power Consumption

Overall we are getting 3% voltage improvement in the Proposed System

$$P = \sqrt{3} VI \cos \phi$$

V (Voltage) increase and because of that I (Current)

decrease in $I \cos \phi$ and the I^2R Losses will Decrease.

Proposed HVDS Estimation

HVDS System Cost				
HT Line Cost				
S.No	Cable Rating	Cable length in Metre	Cable Cost	Amount in Rs
1	300 Sqmm	1450 Metre	1077/metre	15,61,650
2	120 Sqmm	928 Metre	928/Metre	5,84,640
HVDS System Cost				21,46,290

The HT Line Cost for the Existing Low Voltage Distribution System

S.No	Cable Rating	Cable length in Metre	Cable Cost	Amount in Rs
1	300 Sqmm	85 Metre	1077/metre	91,545
2	120 Sqmm	760 Metre	928/Metre	7,05,280
LVDS System Cost				7,96,825

Cable Rating	Cable length in Metre	Cable Cost		Amount in Rs
300 Sqmm	1365 Metre	1077/Metre	14,70,105	
120 Sqmm	168 Metre	928/Metre	1,55,904	16,26,009
Transformer Cost				
Rating	Quantity	Cost/KVA		
50KVA	5	1000/KVA	2,50,000	
100KVA	5	1000/KVA	5,00,000	7,50,000
				23,76,009

Overall Cost for the Proposed HVDS System

So we can assume that, because of the Effect of

- 1) Reduced I^2R Losses (1% Voltage improvement)
- 2) Due to I^2R Losses the Longitivity will increase (1% Voltage improvement)
- 3) Cost Consumption (1% Voltage improvement)

Approximately 3% Voltage improvement per day

If we get 3% Improvement per day then within 30 days, we will get 1 day power consumption free

If we get 3% Improvement per day then within 12 Months, we will get 12 days power consumption free

If we get 3% Improvement per day then within 30 years, we will get 360 days that is nearly 1 year power consumption free.

The Tail End Voltage in Existing System is 407.57V and in the Proposed System the Tail End Voltage is 414.16V.

V. CONCLUSION

We have proposed system where the prevailing large size LT cables are replaced with the HT Cable. In the existing LVDS, the tail end voltage is low resulting in poor voltage regulation. In this work a real time study has been carried out using pscad software. In implementing the HVDS, the existing Distribution system has to be modified into high voltage Distribution system. This may result in the increased length of high voltage conductor by

2 times. further low capacity transformers have to be introduced to get the benefits of HVDS. The Tail End Voltage in Existing System is 407.57V and in the Proposed System the Tail End Voltage is 414.16V.

The Simulation study show that the tail end voltage regulation increases by (15-45) %. the performance of the system will improve with the HVDS.

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